Marginal and Mature Field Development and Operation

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Enhancing Marginal Field Economics through Proven EOR Strategies

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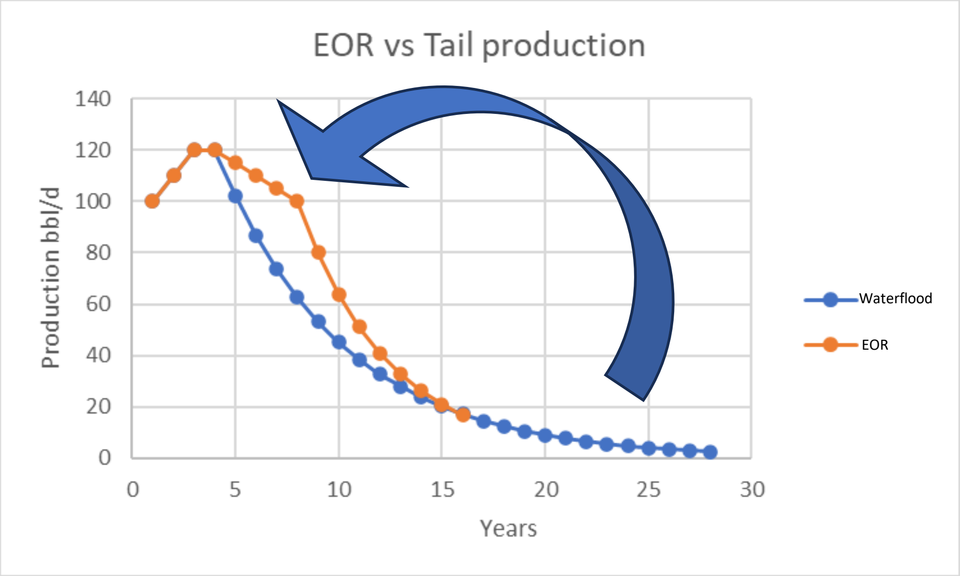
The Challenge

Marginal and Mature oil fields often face economic challenges due to their limited reserves and cost per barrel.

Challenges	
Marginal	Mature
Cost down Recovery Factor & Early Production up Speed up Implementation	Water production down Cost per barrel oil down CO_2 per barrel down

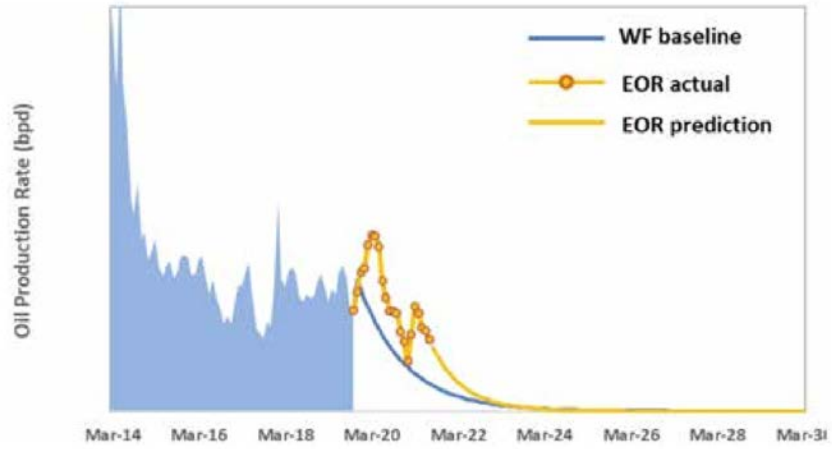
Marginal Fields: Investment, Tax and Payback Time

- Marginal field economics and their viability depend on investment efficiency (bang for your buck), tax conditions, and payback time.
- Therefore, we need three things:
  - Improved recovery and higher oil production. Chemical EOR should be screened against:
    - No further action
    - Infill drilling
    - Waterflooding only
  - Put more weight on Opex to help the tax conditions.
  - Highlighting importance of evaluating payback time. Early oil production gives quick returns and is essential for marginal fields economics.



Mature Fields: Second life

- Mature field economics and their viability depend on reducing the water cut and producing more oil instead of water.
- The focus is on the efficiency of the EOR flood, targeting unswept zones with Polymer: Not just water-recycling
- Not just infill wells, but also use EOR for sweep efficiency
- This also reduces the CO_2 footprint.
  (EAGE IOR 2021, Morice et al)



–EOR Pilot Profile with WF baseline in blue and polymer Injection prediction in yellow.

Sirikit mature field Polymer flood economic analysis
Pancharoen et all, 2022, SPE-210242-MS

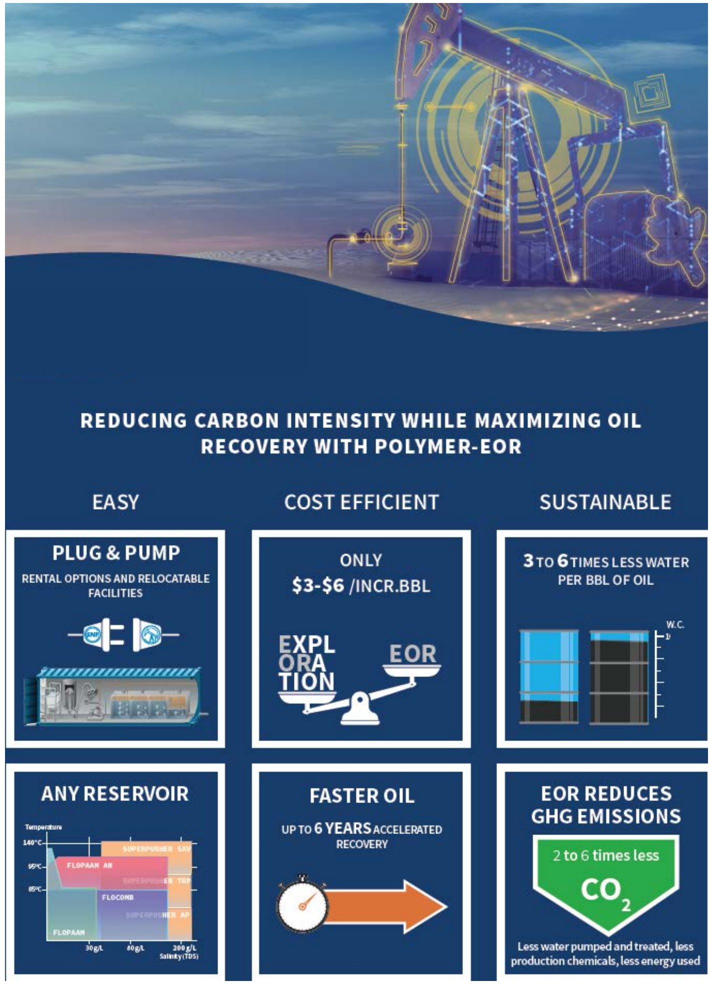
Polymer Flooding: a proven technology

- Proven EOR technology with more than 300 applications worldwide
  - First applications in the US in the 70’s / 80’s
  - China polymer flood in the 90’s
  - Worldwide pilots and full field dev for the past 15 years

- Improves reservoir sweep efficiency
  - Improves mobility control ratio between water and oil
  - Promotes crossflow to increase oil recovery

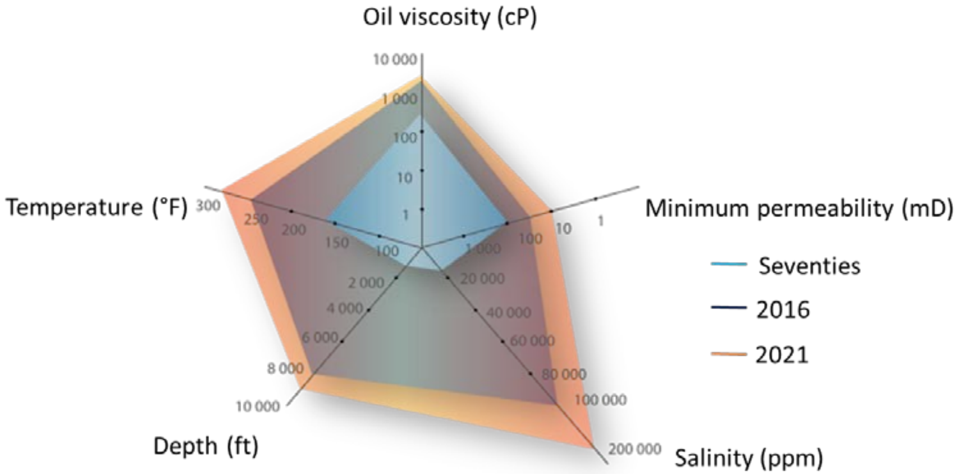
- Cost is limited to \$3 to \$6 per incremental barrel (at Full field scale)
  - Polymer EOR allows recovery of 5 to 20% incremental oil,
  - Cheaper than Exploration & Production activities

- Accelerates oil recovery
  - Operators report up to 6 years of acceleration in recovery
  - Main driver: Water cut reduction
  - Extra Oil production from un-swept area



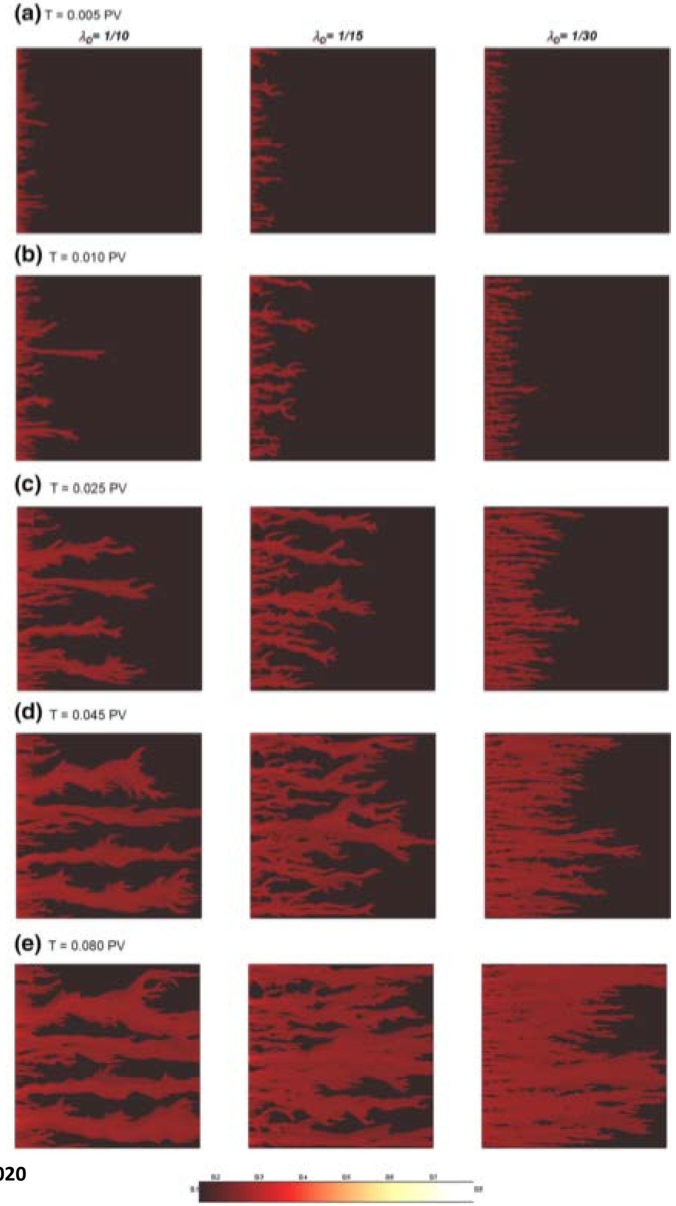
Polymer Flood: viscous waterflooding

Improved mobility ratio leads to more effective flooding



All types of geology, Heterogeneous, Homogeneous

All reservoir conditions, Low & High Perm



On the Modelling of Immiscible Viscous Fingering in Two-Phase Flow in Porous Media
K. S. Sorbie1,2 · A. Y. Al Ghafri1 · A. Skauge2,3 · E. J. Mackay1
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Rethinking EOR as a Long-Term Game

- Traditionally, EOR has been perceived as a long-term endeavor. However, we challenge this notion by exploring low-cost, high-impact chemical EOR techniques that yield rapid results.
- Polymer flooding can be implemented quickly. Predesigned containerized EOR installations can be leased and installed fast-track, speeding up the ROI.
  The lease can be stopped at any time, reducing financial risk.

Marginal fields Methodology

Stage 1
Individual re-evaluation of fields

Stage 2
Evaluation seeking synergies

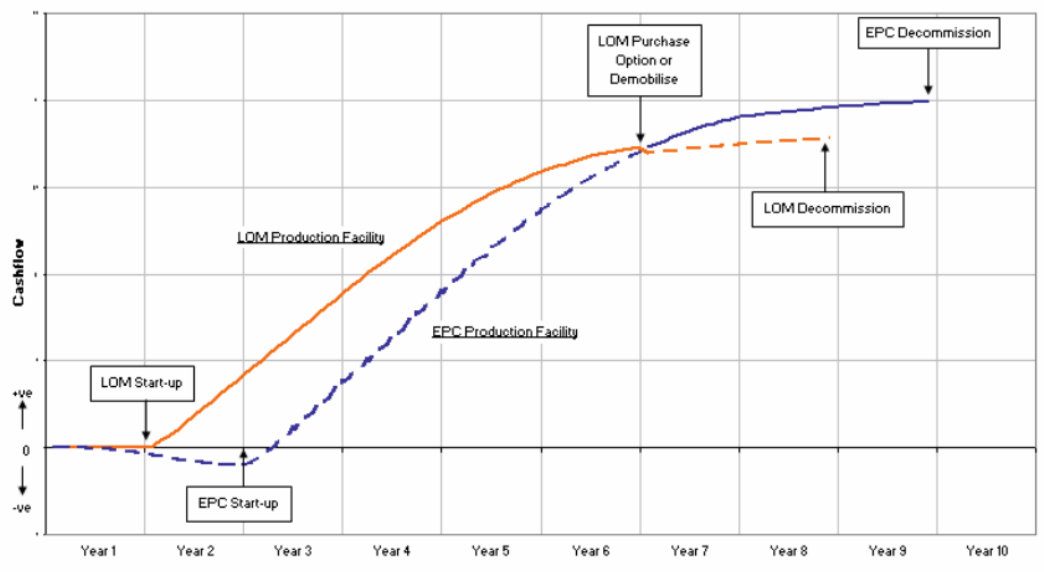
EOR-based re-evaluation: reserves & production	Review required installations	Consolidation and economics	Identifying synergies between fields	Consolidation of final results
Re-evaluate increased production with EOR	Identify the offshore/ onshore structure	# wells Cost Contract-structure (lease)	Scenarios for joint developments of fields	Optimized Prod profiles Optimized flow-lines and structures
• Geoscience • RE • Production • Chemistry	• Engineering	• Cost • Economist • Commercial	• RE • Engineering • Chemistry	• Cost • Economist • Commercial

After: OTC-26230-MS Xochipa et al 2015

Dual Investments: Facilities and Chemicals

- Typical EOR: 80% chemicals (Opex)/20% facilities (Capex)
- Leased EOR: 100 % Opex
- Early implementation of simple chemical EOR like Polymer flooding will positively impact field performance and help economics.

Figure 3: Typical Operator Cash Flow Comparisons



Enhancing Marginal Field development Economics by leasing Operated Production Facilities. SPE 93507

Case Study: Petrogas Rima Oman

- Petrogas Rima fast-tracked their reservoir modeling study (Lawati et al SPE-211209-MS 2022).
- Using leased Polymer Injection facilities for first accumulation
- Now injecting for 2 ½ years in 4 wells
- Second accumulation with leased facilities
- Injecting in 3 wells for 4 months

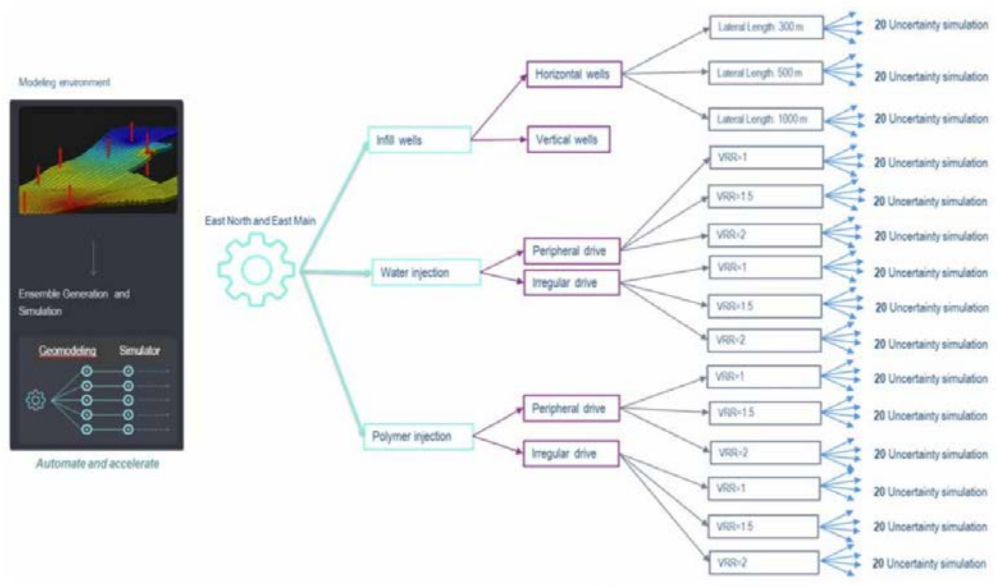


Figure 2—Decision tree leading to 15 scenarios each modeled with an ensemble of 20 cases.

Conclusions

Marginal Fields	Mature Fields
• Cost and financial risk down: • Rethink investment strategies: lease vs own	• Decrease water cut using EOR: • Produce Oil not water
• Increase and accelerate Recovery: • Embrace short-term EOR: Polymer Flood instead of WF	• Decrease water cut using EOR: • Reduce CO_2 footprint
• Speed of implementation: • Leverage fast-track reservoir modeling • Off-the-shelf facilities	• Decrease water cut using EOR: • Combine infill drilling with EOR for optimal sweep efficiency

Thank you and let’s discuss

Jan Nieuwerf

Oil field economics for marginal fields

NPV Calculation

Early Production

$$NPV = \frac{-10}{(1+0.1)^0} + \frac{4}{(1+0.1)^1} + \frac{4}{(1+0.1)^2} + \frac{4}{(1+0.1)^3} + \frac{4}{(1+0.1)^4} + \frac{4}{(1+0.1)^5}$$

$$NPV = -10 + 3.64 + 3.31 + 3.01 + 2.73 + 2.48 = 5.17 \text{ million}$$

Delayed Production

$$NPV = \frac{-10}{(1+0.1)^0} + \frac{0}{(1+0.1)^1} + \frac{4}{(1+0.1)^2} + \frac{4}{(1+0.1)^3} + \frac{4}{(1+0.1)^4} + \frac{4}{(1+0.1)^5} + \frac{4}{(1+0.1)^6}$$

$$NPV = -10 + 0 + 3.31 + 3.01 + 2.73 + 2.48 + 2.25 = 3.78 \text{ million}$$

Comparison

- **Early Production NPV**: $5.17 million
- **Delayed Production NPV**: $3.78 million